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Grain Size Characteristics and Heavy Mineral Analysis of Mahananda River Sediments in Panchagarh District, Bangladesh

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Abstract: **This study investigates the grain size characteristics and heavy mineral assemblages of sediments from the Mahananda River in Panchagarh District, Bangladesh, to infer depositional processes and provenance. Grain size analysis using sieve analysis techniques was conducted to determine the distribution of particle sizes in the sediments. This analysis provides valuable information about the sediment transport dynamics, energy conditions, and sorting processes within the Mahananda River. This research provides comprehensive insights into the depositional environments, and transportation processes within the river system. Such knowledge is essential for effective river management, sediment transport modelling, and environmental impact assessments in the region. Grain size analysis indicates that the sediments are predominantly medium to coarse sand, with graphic mean values ranging from 0.43 to 1.52 ϕ, standard deviation from 0.19 to 0.93 ϕ (moderately to well-sorted), and finely skewed to strongly fine-skewed distributions. The cumulative frequency curves reveal that sediment transport is dominated by traction (90.5%), followed by saltation (8.95%) and suspension (0.55%), suggesting moderate to high energy river conditions. Heavy mineral analysis identified the presence of garnet, ilmenite, rutile, monazite, tourmaline, and sillimanite, reflecting potential economic significance. Overall, the findings provide valuable insights into fluvial processes, sediment provenance, and the mineral resource potential of the Mahananda River system.**

Keywords: ***Grain size, Sediments, Heavy minerals.***

Introduction

Grain size characteristics reflect the hydrodynamic regime and textural maturity of sediments, while heavy mineral assemblages help reconstruct provenance and identify potential economic resources. A heavy mineral in sand is the one having density greater than quartz (SiO_2), the most abundant rock-forming mineral, which has a density of 2.65 g/cm^3 (Rahman et al., 2021).

Several studies have investigated the heavy mineral composition of major rivers in Bangladesh. Hossain et al. (2021) analyzed the heavy mineral assemblages of Jamuna River sediments, while Rahman et al. (2022) examined the distribution and characterization of heavy minerals in Meghna River sand deposits. However, research on the Mahananda River in Panchagarh remains limited, despite its significant heavy mineral content, indicating a clear research gap in this region. The study was carried out on the Mahananda River in Panchagarh District, northwestern Bangladesh (Figure 1).

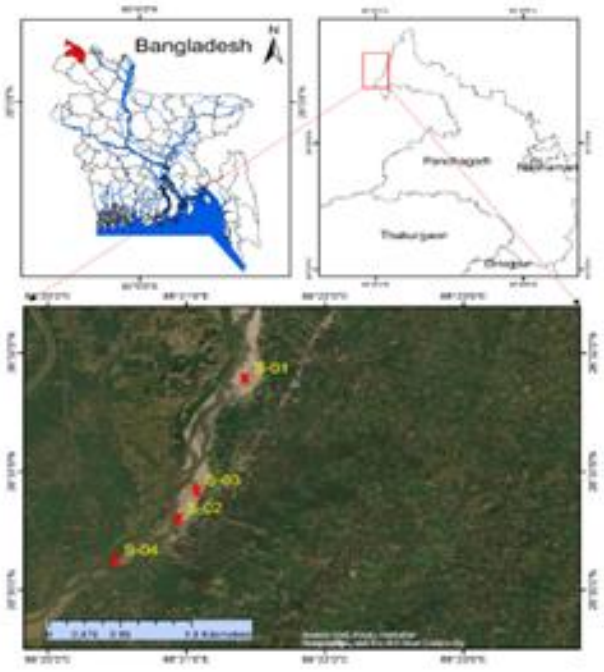

Figure 1, Location map of the study area.

Methodology

Field work and sample collection

A total of 4 sediment samples were collected from active riverbeds of Mahananda rivers. Samples were taken from surface layers (>10 cm depth) using a hand auger and stored in labeled polyethylene bags.

Grain size analysis

Sediment samples were air-dried, sieved, and the cumulative percentage retained on each sieve was plotted on probability paper to construct grain size curves. Textural parameters, including Mean, Standard Deviation, Skewness, and Kurtosis, were calculated

following Folk and Ward (1957) and Friedman and Johnson (1982).

Heavy mineral separation

The sand-size fraction of sediment samples was treated with 10% HCl to remove organic matter and carbonates, followed by repeated washing with distilled water and oven-drying at 105°C. Heavy minerals were separated using bromoform in a separatory funnel, allowing dense minerals to settle while light fractions were discarded.

Microscopic observation of heavy minerals

Heavy minerals were identified based on key physical properties under reflected microscope. These are color, luster, transparency and shape.

Results and analysis

The cumulative frequency curves suggest that most of the particles were transported by 90.5% of the traction population in the Mahananda River, followed by the saltation population 8.95% in the Mahananda River. The suspension population accounts for only 0.55% in the Mahananda River. These figures indicate a moderate to high energy condition of the rivers. The graphic mean (Mz) ranges between 1.52-0.43 in the Mahananda River, indicating medium to coarse-grained sand. Inclusive standard deviation (σ_i) varies from 0.93-0.19 in the Mahananda River suggesting moderate to well-sorted grains. It can also be included that most of the samples are finely skewed (Table 1).

Table 1, Results of the statistical parameters of the samples studied.

River	Station No.	Mean (Mz)		Standard deviation (σ_g)		Skewness (sk_i)		Kurtosis (k_g)	
		Value	Interpretation	Value	Interpretation	Value	Interpretation	Value	Interpretation
Mahananda	01	1.07	Medium grain sand	0.19	Very Well sorted	1.0	Finely skewed	1.25	Leptokurtic
	02	0.43	Coarse grained sand	0.76	Moderately sorted	1.0	Finely skewed	1.3	Leptokurtic
	03	0.72	Coarse grained sand	0.93	Moderately sorted	1.0	Finely skewed	0.71	Platykurtic
	04	1.52	Medium grained sand	0.42	Well sorted	0.54	Strongly finely skewed	1.16	Mesokurtic

Heavy mineral assemblage

Garnet: Mostly almandine; pinkish-red, glassy, and partially transparent, appearing dark gray, brown under reflected light.

Ilmenite: Black, submetallic, and opaque, easily distinguishable.

Rutile: Reddish with brilliant luster and partial transparency, clearly identifiable.

Monazite: Yellowish, resinous, and partially transparent, allowing easy recognition.

Tourmaline: Greenish, vitreous, and partially transparent, readily identifiable.

Sillimanite: White, silky, and translucent, easily distinguished from other heavy minerals (Figure 2).

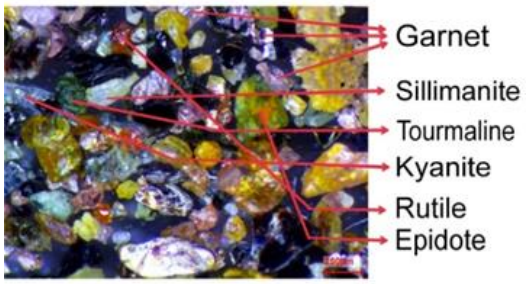

Figure 2, Heavy mineral assemblage.

Conclusion

The Mahananda River sediments are predominantly medium to coarse sand, characterized by moderate to well sorting and finely skewed distributions, indicating deposition under moderate to high energy conditions. Grain size analysis reveals traction as the dominant transport mechanism, followed by saltation and minor suspension. The heavy mineral assemblage, including garnet, ilmenite, rutile, monazite, tourmaline, and sillimanite, reflects potential economic significance. These findings enhance understanding of sediment dynamics and depositional processes in the river system. Overall, the study provides a valuable basis for fluvial geomorphology and resource evaluation.

References

Folk, R. L., and Ward, W. C. (1957). Brazos River bar: A study in the significance of grain size parameters. Journal of Sedimentary Research, 27(1), 3–26. https://doi.org/10.1306/74D70646-2B21-11D7-8648000102C1865D

Friedman, G. M. (1967). Dynamic processes and statistical parameters compared for size frequency distribution of beach and river sands. Journal of Sedimentary Research, 37(4), 327–354. https://doi.org/10.1306/74D716CC-2B21-11D7-8648000102C1865D

Hossain, M. S., Aziz, M. T., Shahriar, M. S., and Ritu, A. (2021). Heavy mineral analysis of Jamuna River sediments, Bangladesh. Journal of the Geological Society of India, 97(5), 470–480. https://doi.org/10.1007/s12594-021-1713-3

Rahman, A., Pownceby, M. I., Tardio, J., Sparrow, G. J., Haque, N., and Hasan, F. (2021). Distribution, separation and characterisation of valuable heavy minerals from the Brahmaputra River Basin, Kurigram District, Bangladesh. Minerals, 11(7), 786. https://doi.org/10.3390/min11070786

Rahman, M. J. J., Pownceby, M. I., and Rana, M. S. (2022). Distribution and characterization of heavy minerals in Meghna River sand deposits, Bangladesh. Ore Geology Reviews, 143, 104773. https://doi.org/10.1016/j.oregeorev.2022.104773